Vector Calculus plays an important role in Engineering to understand the concept of Electrodynamics

- Dot Product: Let $\bar{a}$ =$a_1\bar{\imath}$ + $a_2\bar{\jmath}$ + $a_3\bar{k}$, $\bar{b}$=$b_1\bar{\imath}$+ $b_2\bar{\jmath}$ + b_3 $\bar{k}$ be two vectors then the dot product of two vectors is $\bar{a}.\bar{b}$ =$a_1b_1 + a_2b_2 + a_3b_3$

- Cross product: Let $\bar{a}$ =$a_1\bar{\imath}$ + $a_2\bar{\jmath}$ + $a_3\bar{k}$,$\bar{b}$=$b_1\bar{\imath}$+ $b_2\bar{\jmath}$ + $b_3\bar{k}$ be two vectors then the Cross product of two vectors is $\bar{a} \times \bar{b}=\begin{vmatrix} \bar{\imath} & \bar{\jmath} & \bar{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$.

- Scalar Triple product/ Box product:

  $|\bar{a} \quad \bar{b} \quad \bar{c}|$ = ā. ($\bar{b}\times\bar{c}$)=$\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$

- Vector Triple Product: ā × ($\bar{b}\times\bar{c}$)= $(\bar{a}.\bar{c})\bar{b}$- $(\bar{b}.\bar{a})\bar{c}$

- Angle between ā= $a_1\bar{\imath}$ + $a_2\bar{\jmath}$ + $a_3\bar{k}$, $\bar{b}$=$b_1\bar{\imath}$+ $b_2\bar{\jmath}$ + b_3 $\bar{k}$

$$\cos\theta = \frac{\bar{a}.\bar{b}}{|\bar{a}||\bar{b}|} = \frac{a1b1+a2b2+a3b3}{\sqrt{{a_1}^2+{a_2}^2+{a_3}^2}\sqrt{{b_1}^2+{b_2}^2+{b_3}^2}}$$

- Gradient of Scalar Function ϕ: $\nabla\phi = \bar{\imath}\frac{\partial\phi}{\partial x} + \bar{\jmath}\frac{\partial\phi}{\partial y} + \bar{k}\frac{\partial\phi}{\partial z}$

- The D.D of ϕ at (x, y, z) along the direction of vector ā is=$\nabla_{(x,\, y,\, z)}.\hat{a}$

- Divergence of Vector Field $\bar{F}$: $\nabla.\bar{F} = \frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z}$

- A vector field $\bar{F}$ is Solenoidal if and only if $\nabla.\bar{F} = 0$

- Curl of Vector Field $\bar{F}$: $\nabla.\bar{F} = \begin{vmatrix} \bar{\imath} & \bar{\jmath} & \bar{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial x} & \frac{\partial}{\partial x} \\ F_1 & F_2 & F_3 \end{vmatrix}$

- A vector field $\bar{F}$is Irrotational if and only if

$\nabla \times \bar{F} = 0$, we find scalar function or scalar potential $\emptyset = \int F_1 dx + \int_{Terms\ free\ from\ x} F2dx$ $+ \int_{Terms\ free\ from\ (x,y)} F3dx + C$

$\nabla\times\bar{r} = 0$, $\nabla\times\bar{a} = 0$, $\nabla(\bar{a},\bar{r}) = \bar{a}$	$\nabla^2 f(r) = f''(r) + \frac{2}{r} f(r)$, $\nabla f(r) = f'(r)\frac{\bar{r}}{r}$
$\nabla r = \frac{\bar{r}}{r}$, $\nabla . \bar{r} = 3$	$\nabla.(\emptyset\bar{u}) = \nabla\emptyset.\bar{u} + \emptyset(\nabla.\bar{u})$
$\nabla.(\bar{u}\times\bar{v}) =$ $\bar{v}.(\nabla\times\bar{u}) - \bar{u}.(\nabla\times\bar{v})$	$\nabla\times(\emptyset\bar{u}) = \nabla\emptyset\times\bar{u} + \emptyset(\nabla\times\bar{u})$
$\nabla \times (\nabla\emptyset) = 0$	$\nabla.(\nabla\times\bar{u}) = 0$